

1 **"APPARATUS AND PROCESS FOR COALESCING**
2 **BITUMEN IN AN OIL SAND SLURRY"**

3 **FIELD OF THE INVENTION**

4 The present invention relates to a process for treating an
5 aqueous oil sand slurry to enhance the probability of bitumen
6 droplet contact and coalescence.

7
8 **BACKGROUND OF THE INVENTION**

9 Oil sand, as known in the Fort McMurray region of Alberta,
10 comprises water-wetted sand grains having viscous bitumen flecks
11 trapped between the grains. It lends itself to separating or
12 dispersing the bitumen from the sand grains by slurring the as-
13 mined oil sand in heated water so that the bitumen flecks disperse
14 into the aqueous phase.

15 The bitumen in McMurray oil sand has been commercially
16 recovered at applicant's plant for the past 25 years. Initially this
17 was done using the following general scheme (referred to as the
18 "hot water process"):

- 19 • dry mining the oil sand at a mine site that was kilometers
20 from an extraction plant;

1 conveying the as-mined oil sand on conveyor belts to the
2 extraction plant;

3 • feeding the oil sand into a rotating tumbler where it was
4 mixed for a prescribed retention time with hot water
5 (80°C.), steam, caustic and naturally entrained air to yield
6 a slurry typically having a temperature of 80°C. During this
7 operation, bitumen flecks were heated and became less
8 viscous . Chunks or lumps of oil sand were ablated or
9 disintegrated. The sand grains and bitumen flecks were
10 dispersed or separated in the water. To some extent
11 bitumen flecks contacted, coalesced into droplets and
12 grew in size. The bitumen droplets contacted air bubbles
13 and coated them or connected with them to become
14 aerated bitumen. The term used to describe this overall
15 process in the tumbler is "conditioning";

16 • the slurry produced was then diluted with additional hot
17 water and introduced into a large, open-topped, conical-
18 bottomed, cylindrical vessel (termed a primary separation
19 vessel or "PSV"). The diluted slurry was retained in the
20 PSV under quiescent conditions for a prescribed retention
21 period. During this period, aerated bitumen droplets rose

1 and formed a froth layer. The froth overflowed the top lip
2 of the vessel and was conveyed away in a launder. The
3 sand grains sank and were concentrated in the conical
4 bottom – they left the bottom of the vessel as a wet tailings
5 stream. Middlings, a watery mixture containing solids and
6 relatively non-buoyant bitumen, extended between the
7 froth and sand layers. The term used to describe this step
8 is "spontaneous flotation";

- 9 • the tailings and middlings were withdrawn, combined and
10 sent to a secondary flotation process carried out in a deep
11 cone vessel wherein air was sparged into the vessel to
12 assist with flotation. This vessel is referred to as the TOR
13 vessel. It and the process conducted in it are disclosed in
14 U.S. Patent No. 4,545,892. The bitumen recovered was
15 recycled to the PSV; and
- 16 • the middlings from the deep cone vessel were further
17 processed in air flotation cells to recover contained
18 bitumen. The term used to describe the mechanisms in
19 the TOR and air floatation cells are collectively referred to
20 as "secondary flotation".

1 A fairly recent change with respect to this procedure
2 involved:

- 3 • supplying heated water at the mine site;
- 4 • pre-crushing the dry, as-mined oil sand, for example to –
5 24 inches;
- 6 • mixing the pre-crushed oil sand with the heated water and
7 entraining air, at the mine site, to form a pumpable slurry
8 having a temperature, for example in the order of 50°C;
9 and
- 10 • pumping the slurry through a pipeline directly to a PSV to
11 subject it to spontaneous flotation.

12 This procedure relies on the mechanisms of conditioning being
13 completed satisfactorily as the slurry moves through the pipeline
14 so that, when the slurry is retained in the PSV, a viable proportion
15 of the contained aerated bitumen reports to the froth layer.

16 It needs to be understood that the composition and
17 processability of oil sand varies, often significantly. As a
18 consequence, we have noted that, from time to time, the pipelined
19 oil sand slurry produces unsatisfactory primary froth yield in the
20 PSV. We believe that one reason for this may be that the
21 residence time in the pipeline may be too short for that particular

1 oil sand and that the bitumen droplets do not coalesce and grow to
2 a size suitable for aeration and flotation.

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4 **SUMMARY OF THE INVENTION**

5 With this background in mind, we have devised an apparatus
6 and process for treating an aqueous aerated oil sand slurry to
7 increase the probability that bitumen droplets will contact and
8 coalesce to grow in size. In addition, small non-aerated droplets
9 may coalesce and grow to a size that will readily aerate.

10 More particularly:

- 11 • an assembly is provided comprising a coalescer and a
12 bitumen/sand separator (such as a PSV or a
13 cycloseparator). These units are operatively connected in
14 series to process a stream of aqueous oil sand slurry;
- 15 • the coalescer is an elongate closed vessel forming a
16 chamber having a circular cross-section, the vessel further
17 having means, such as a tangential inlet at its inlet end, for
18 introducing slurry feed and inducing it to rotate about the
19 vessel's longitudinal axis as it advances through the
20 chamber, and an outlet at its other end;

1 slurry is injected under pressure into the vessel chamber
2 through the inlet means with the result that bitumen
3 droplets are caused to move inwardly and to concentrate
4 in the central core of the advancing flow, whereby the
5 bitumen droplets contact, coalesce and grow; and

- 6 • the so-treated slurry stream is then expelled through the
7 coalescer outlet and is conveyed through a pipeline into
8 the separator, for separation of sand and bitumen.

10 DESCRIPTION OF THE DRAWINGS

11 Figure 1 is a schematic showing a circuit for processing a
12 stream of aqueous, aerated bitumen slurry; and

13 Figure 2 is a partly broken away side view of the coalescer,
14 forming part of the circuit of Figure 1, with arrows indicating the
15 slurry flow through the vessel inlet, its rotational flow along its
16 length and its exit through the outlet.

1 **DESCRIPTION OF THE PREFERRED EMBODIMENT**

2 The preparation of slurry, pipelining and bitumen/sand
3 separation of an aqueous oil sand slurry is known technology in
4 the oil sand industry. Typically, the as-mined oil sand is pre-
5 crushed to -24 inches using a double roll crusher 1. The crushed
6 oil sand is then mixed with heated water and air and partly
7 conditioned in a mixer 2. Oversize material is rejected by passing
8 the slurry through a screen 3. The aerated slurry is collected in a
9 pump box 4 and is then pumped through a pipeline 5, thereby
10 advancing conditioning, and is introduced into a sand/bitumen
11 separator 6, such as a cycloseparator.

12 In accordance with the present invention, a coalescer 7 is
13 connected with the pipeline 5, upstream of the separator 6.

14 The coalescer 7 is an elongate, closed, preferably cylindrical
15 vessel 8 forming an interior chamber 9 of circular cross-section.
16 The vessel 8 has a tangential inlet 10 at one end. The inlet 10 is
17 connected with the pipeline 5. At its opposite end, the vessel 8
18 has an outlet 11, preferably axial, which is connected with the
19 separator 6.

20 In use, pipeline slurry is injected under pressure into the
21 chamber 9 through the tangential inlet 10. The slurry rotates as it

1 proceeds to advance longitudinally through the chamber 9. Under
2 the influence of centrifugal force, the lighter bitumen and water
3 migrate inwardly and the heavier sand migrates outwardly. The
4 entire stream, now somewhat stratified, is expelled through the
5 outlet 11 and is introduced back into the pipeline 5 and eventually
6 into the separator 6 for separation of the bitumen and sand.

7 By centrally concentrating the bitumen droplets in the stream
8 moving through the coalescer 7, a greater opportunity or
9 probability is provided whereby the individual bitumen droplets
10 may contact, coalesce and grow into larger droplets better able to
11 unite with air bubbles to form buoyant bitumen. As a result, the
12 performance of the separator 6 may be enhanced.

13 Although a preferred embodiment has been shown and
14 described, it will be appreciated by those skilled in the art that
15 various changes and modifications might be made without
16 departing from the scope of the invention, as defined in the
17 appended claims.

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